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SHORT PAPER

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The prevalence of excessive sleepiness is higher in shift workers than in patients with obstructive sleep apnea

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Abstract

Excessive daytime sleepiness (EDS) is a common feature among shift workers as well as in obstructive sleep apnea (OSA) patients. There are several important accidents related to sleep disturbances causing EDS. The aim of this study was to evaluate EDS in a group of shift workers (regular rotating) from civil aviation and to compare them with OSA patients (n = 300) and with a group of regular workers (RW) (n = 140). Our sample was composed of 730 working-age individuals (aged 18–67 years). The regular rotating shift workers (SW) sample was composed of 290 aeronautical mechanics. EDS was evaluated with the Epworth Sleepiness Scale (ESS) and defined as a score ≥ 11. The prevalence value obtained for the EDS of RW was 37.1%, for SW it was 60.7% and for OSA patients it was 40.7%. A logistic regression model for EDS in a subsample composed of men and matched for age and BMI, controlling for self-reported sleep duration, showed an increased risk of EDS for SW (OR = 3.91, p = .001), with the RW group as reference. OSA patients did not differ from RW on EDS levels. This study emphasizes the presence of EDS in a shift work group of civil aviation professionals, which exceeded the EDS level of a positive control group of OSA patients. Sleep hygiene education for companies' workers and management is important and mitigation strategies should be implemented to reduce excessive sleepiness among workers.

KEYWORDS

Epworth Sleepiness Scale, obstructive sleep apnea, shift work

1 | INTRODUCTION

Shift work is any work schedule outside conventional daytime hours that implies workers are on duty for time periods that supposedly should be used for sleep according to their biological rhythm. This includes very early mornings, and evening and night shifts. These shifts can be fixed or rotating (Kecklund & Axelsson, 2016). Disrupted sleep is one of the known consequences of shift work, leading to fatigue, insomnia symptoms and excessive daytime sleepiness (EDS) (Booker, Magee, Rajaratnam, Sletten, & Howard, 2018), which can even persist during time off (Vantolla, Sampsa, Kati, Tuula, & Mikko, 2020). These have major consequences for their lives, at personal and work levels, and can lead to lower performance, and increased risk of motor-vehicle and work-related accidents (Åkerstedt, 2019; MacLean, Davies, & Thiele, 2003). Short sleep or poor sleep quality could also be a mediator of the relationship between shift work and adverse health effects (Kecklund & Axelsson, 2016). Civil aviation professions frequently involve shift work and consequent EDS; however, it is of utmost importance that supervision of these profession is maintained in to avoid any possible hazards, such as air travel accidents.

The Epworth Sleepiness Scale (ESS) is one of the most frequently used instruments to evaluate EDS in research and clinical settings. Obstructive sleep apnea (OSA), on the other hand, is one of the most prevalent sleep disorders, particularly in men. OSA is

TABLE 1 Sample characteristics

	Total sample				Subsample[a]			
	OSA (n = 300)	RW (n = 140)	SW (n = 292)	p-value	OSA (n = 62)	RW (n = 50)	SW (n = 62)	p-value
Sociodemographic								
Age, yr, median (interquartile range)	53.0 (16.0)	40.0 (23.0)	39.0 (12.0)	<.001	47.0 (13.0)	46.0 (14.0)	47.0 (13.0)	.950
Sex, n (%M)	202 (67.3)	90 (64.3)	283 (96.9)	<.001	62 (100)	50 (100)	62 (100)	n.a.
BMI, kg/m^2, median (interquartile range)	30.4 (7.7)	24.5 (5.9)	25.7 (5.1)	<.001	26.5 (4.7)	25.8 (5.0)	26.0 (4.2)	.494
Sleepiness								
ESS score, median (interquartile range)	9.0 (7.0)	9.0 (7.0)	12.0 (6.0)	<.001	11.0 (7.0)	10.0 (8.0)	14.0 (5.0)	<.001
ESS < 11, n (%)	178 (59.3)	88 (62.9)	114 (39.0)	<.001	30 (48.4)	27 (54.0)	14 (22.6)	.001
ESS ≥ 11, n (%)	122 (40.7)	52 (37.1)	178 (61.0)		32 (51.6)	23 (46.0)	48 (77.4)	
Sleep duration,								
self-report, mean (interquartile range)	7 hr 00 (1 hr 33)	7 hr 00 (1 hr 45)	6 hr 18 (1 hr 19)	<.001	7 hr 00 (2 hr 00)	6 hr 42 (1 hr 30)	6 hr 25 (1 hr 45)	.009

Abbreviations: BMI, body mass index; ESS, Epworth Sleepiness Scale; n.a., non-applicable; OSA, obstructive sleep apnea; RW, regular work; SW, shift work.

[a]Samples composed of only men and matched for age and BMI.

often associated with EDS (Javaheri & Javaheri, 2020) and reported as an important risk factor for accidents and reduced productivity (Sateia, 2014). Like OSA, EDS is very common among shift workers (Åkerstedt, 2019). The aim of this study was to evaluate EDS in a group of shift workers and to compare them with OSA patients as a positive control group and regular workers as a negative control group.

2 | METHODS

2.1 | Participants

Our sample was composed of 730 working-age individuals (age range, 18–67 years). As a negative control group, 140 individuals (age range, 18–65 years; median age = 40.0 [IQR, 23.0]; 90 males) were recruited from the general population. All reported absence of sleep disorders and regular working schedules (regular workers [RW]). Furthermore, we investigated 290 shift workers (SW), who were aeronautical maintenance technicians who worked regular rotating backward schedules, with 4 days of work plus 2 days off (i.e., M-M-M-M-Off-Off), rotating after the days off (age range, 22–62 years; median age = 39.0 [IQR, 12.0]; 281 males). As a positive control group, 300 non-shift-worker patients with untreated OSA were included (age range, 18–67 years; median age = 53.0 [IQR, 16.0]; 202 males). Subjects who were on sick leave, parental leave or unemployed were excluded from the regular and shift work groups. Patients' groups were diagnosed according to the ICSD3 criteria (Sateia, 2014); they underwent an in-laboratory polysomnography and were clinically evaluated by a sleep medicine specialist. The RW group was also interviewed by a sleep medicine specialist. The SW with OSA symptoms according to the Karolinska Sleep Questionnaire (Westerlund, Brandt, Harlid, Åkerstedt, & Trolle Lagerros, 2014) were excluded. All participants were of active working age (18–67 years old).

2.2 | Procedures

This study included cohorts from different studies that included the evaluation of EDS by the ESS and self-reported sleep duration. The ESS is a brief self-administered eight-item questionnaire that requires the subject to rate, on a scale from 0 to 3, his/her chances of dozing in eight different situations. The score can range from 0 to 24, with higher scores representing a higher degree of sleepiness. EDS is defined for values of ESS score ≥ 11 (Johns, 1992).

SW and RW answered the ESS questions and a questionnaire on sociodemographic and working data. Patients were recruited from the CENC–Sleep Medicine Centre and from the Sleep Laboratory, Pneumology Unit of the Hospital de Santa Maria, Centro Hospitalar Universitário Lisboa Norte. All patients answered the ESS questions during their first appointment for the investigation of sleep-related breathing disorders. All individuals gave their informed consent for data collection. Studies were submitted to the Ethical Committee of the Lisbon Medical School.

2.3 | Statistical analyses

All variables were analysed using descriptive statistics (median [interquartile range]). Normality was analysed by the Shapiro-Wilk test. Categorical variables were described as absolute frequency and percentage. Independent sample comparison (Kruskal-Wallis test [KW]) for ESS scores was performed for the different groups, with a pairwise comparison test. Patients were grouped according to disease severity. The applied intervals are based on established values of the apnea–hypopnea index (AHI): 5–15 mild, 16–30 moderate and >30 severe OSA (Hudgel, 2016). The KW test was performed to check differences between disease severity groups and ESS score, as well as a χ^2 test for the different disease severity groups: with (ESS ≥ 11) and without (ESS < 11) daytime sleepiness. A logistic regression model for EDS was performed for a subsample of men due to the reduced number of women among SW, who were matched for age and body mass index (BMI). Individuals responding during or after a night shift were also excluded from the subsample in order to avoid a potential overestimation of sleepiness symptoms. All tests were considered as statistically significantly for a $p < .05$. Analysis was performed with SPSS v.25 and graphs produced with Prism 8.

3 | RESULTS

Groups differed insofar as OSA patients demonstrated a statistically significant higher age ($p < .001$) compared with other groups, but there was no statistically significant difference between RW and SW. The BMI of RW was 24.5 (IQR, 5.9) kg/m^2, ranging from 16.3 to 37.1 kg/m^2; for the SW it was 25.7 (IQR, 5.1) kg/m^2, ranging from 18.3 to 49.4 kg/m^2; for the OSA group it was 30.4 (IQR, 7.0) kg/m^2, ranging from 18.59 to 59.56 kg/m^2. The BMI for the OSA group was significantly higher ($p < .001$).

Seventy-two (9.9%) of the SW answered the questionnaire on a day off, 86 (11.8%) during or after a morning shift, 100 (13.7%) during or after an evening shift and 32 (4.4%) during or after a night shift. We tested for a reporting bias of sleep duration among the SW group for the time of day the questionnaire was answered and no differences were found (KW = 0.964; $p = .810$).

The median ESS score for RW was 9.0 (IQR, 7.0), ranging from 0 to 21; for SW it reached a value of 12.0 (IQR, 6.0), ranging from 0 to 22; for OSA patients the median ESS was 9.0 (IQR, 7.0), ranging from 0 to 24. The prevalence of EDS was 37.1% in RW, 60.7% in SW and 40.7% in OSA patients (Table 1).

The multiple groups comparison analysis demonstrated a significantly lower ESS for the RW group relative to the SW group (KW = −114.64; $p < .001$). Results did not reach statistical significance when the RW and the OSA group were compared, although the RW group presented, on average, a lower score. The OSA patients had a lower ESS score in comparison to the SW group (KW = −117.36; $p < .001$) (Figure 1).

A logistic regression model for EDS for a subsample of individuals was run, including as covariables self-reported sleep duration and groups. The variable with a predictive value for EDS was groups ($p = .002$), with the shift work group presenting an increased risk of EDS: SW (OR = 3.91 [3.91–8.87], $p = .001$) (Table 2).

The OSA group was composed mainly of moderate-severity patients, AHI = 22.3 (IQR, 35.5), ranging from 5.2 to 132.4 events/hr, with a median sleep efficiency of 83.1% (IQR, 15.8), ranging from 15.5% to 98.4%. The EDS for the OSA group did not differ among the disease severity groups (Pearson $\chi^2 = 2.01$; $p = .37$) (Table 3).

4 | DISCUSSION

Our study demonstrated a high prevalence of EDS in civil aviation aeronautical maintenance technicians working rotating shift work routines. The subjective sleepiness surpassed the values seen in non-shift-worker patients with a significant OSA. This might be due to the reduced average sleeping hours and or a particularly bad schedule for the mechanics. Sleepiness has been associated with shift work, namely performing night work (Åkerstedt, 2019; Åkerstedt, Anund, Axelsson, & Kecklund, 2014), which was the case for the shift work group studied here. Shift workers were the ones with significantly higher scores for EDS in comparison to the RW and OSA patients, showing that this is a relevant issue, especially if we consider that the shift work group is performing a highly demanding job and their attention might be compromised. Slower reaction times and EDS were already shown in members of the Navy on active duty (Shattck & Matsangas, 2015). High levels of EDS have already been described for other civil aviation professionals performing irregular work rotations (airline pilots), with a prevalence of 59.3% (Reis, Mestre, Canhão, Gradwell, & Paiva, 2016), but in the present study EDS levels were even higher for regularly rotating workers (60.7%). These workers are performing regular (4 days) and backward rotations (night-evening-morning), and these can be some of the causes of the obtained values for EDS. It was shown that this type of rotation can impact sleep and fatigue in shift workers (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008; Kecklund & Axelsson, 2016). For airline pilots, work and rest times have been regulated (EASA, 2018) due to the high demand of their job, but for aeronautical maintenance technicians these are not yet established, although their job is equally demanding, where failures impact the safety of an aircraft. In the present report it was shown that they have an increased risk of EDS, controlling for age and BMI (known influencing factors for excessive sleepiness) (Booker et al., 2018), increasing the risk of error. Furthermore, it is important to highlight that aeronautical mechanics usually work alone, unlike airline pilots.

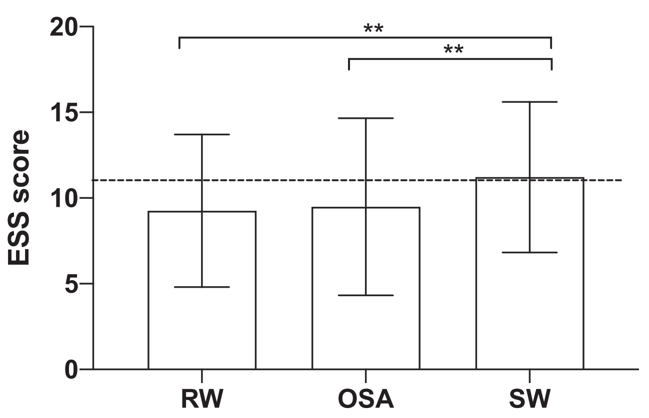

FIGURE 1 Group comparisons of Epworth Sleepiness Scale (ESS) scores (box, mean values; whiskers, standard deviation) (KW = 59.97; $p < .001$) with pairwise group comparison test ($n = 730$). OSA, obstructive sleep apnea; RW, regular work; SW, shift work. Dashed line represents the cut-off point for excessive daytime sleepiness (ESS ≥11). $^{**}p < .01$

Something that needs to be considered is that some of the shift workers with higher levels of sleepiness are likely to also have shift work disorder due to the high prevalences observed in other groups of SW (Booker et al., 2018; Vantolla et al., 2020). We could show that regular rotation backward schedules might have an increased risk.

Regular workers also showed high levels of EDS, almost as high as in OSA patients. Social jetlag is a common feature among the general population (Wittmann, Dinich, Merrow, & Roenneberg, 2006), leading to EDS, and this might be an influencing factor for EDS in our RW group.

As reported previously, we also found that many OSA patients do not report EDS (He & Kapur, 2017). Importantly, many individuals with higher OSA severity (AHI > 30 events/hr) reported low levels of EDS. The low sensitivity of the ESS is particularly relevant because without complaints it is more difficult to identify subjects in need of OSA treatment (Knauert, Naik, Gillespie, & Kryger, 2015).

This study was performed with large samples, giving some robustness to our results, but has some limitations. Only the OSA patients performed a regular polysomnographic study. It would be important to compare the results of the OSA patients with objective sleep analysis in the other groups. This would also exclude the possible presence of other, not so far detected, sleep disorders among the shift work group. Due to the reduced number of women in the shift work group, the logistic regression model was analysed just for men, although adjusted for age and BMI. It would be important to investigate in shift workers a possible gender difference for EDS. ESS is a subjective instrument for evaluating EDS and people have different perceptions about their sleepiness. OSA patients sometimes have a true perception of their bad sleep and respective sleepiness after treatment (Guimarães, Martins, Vaz Rodrigues, Teixeira, & Moutinho dos Santos, 2012).

Evaluation of an SW group performing forward rotations would also be important in order to understand whether the high EDS levels of the SW are due to their backward rotation. To perform an intervention programme, monitoring actual sleep–wake behaviour

TABLE 2 Logistic regression analysis for excessive sleepiness (ESS ≥ 11)

	β	*SE* β	Wald's χ^2	*df*	*p*-value	Odds ratio	95% CI Lower	95% CI Upper
Sleep duration	−0.167	.139	1.443	1	.230	0.846	0.644	1.112
Group			12.169	2	.002			
SW	1.365	.418	10.679	1	.001	3.914	1.727	8.879
OSA	0.215	.391	0.303	1	.582	1.240	0.576	2.670
Constant	0.943	.961	0.963	1	.326	2.568		

Note: Model performed for men and groups were matched for age and body mass index. $n = 170$ (RW = 50, SW = 62, OSA = 58). For variable Group the reference group was RW. Hosmer-Lemeshow test χ^2 (8) = 4.669, $p = .792$.

Abbreviations: CI, confidence interval; *df*, degree of freedom; OSA, obstructive sleep apnea; RW, regular work; *SE*, standard error; SW, shift work.

TABLE 3 Excessive daytime sleepiness (ESS ≥11) according to OSA disease severity groups

OSA	ESS < 11	ESS ≥11
Mild	45 (25.3%)	40 (32.8%)
Moderate	60 (33.7%)	37 (30.3%)
Severe	73 (41.0%)	45 (36.9%)

Note: $n = 300$; Pearson $\chi^2 = 2.01$; $p = .37$. ESS, Epworth Sleepiness Scale; OSA, obstructive sleep apnea.

(Riedy, Roach, & Dawson, 2020), with these workers (changing to forward rotation) could also be an important option.

This study showed that EDS is very prevalent among shift workers and that in this cohort working conditions were a greater influence than the presence of OSA. We also showed that to rely on subjective EDS for the diagnosis of OSA may not be good enough because the more severe patients were the ones with fewer sleepiness complaints. Sleep hygiene education for companies' workers and management is important for implementing mitigation strategies for EDS and fatigue.

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CONFLICT OF INTEREST

No conflicts of interest declared.

AUTHOR CONTRIBUTIONS

CR, RS, PP, TAA, CB and TP contributed to the design of the study. CR, RS, PP, CB and TP carried out sample collection. CR performed the statistical analysis and wrote the manuscript. All authors revised the manuscript and approved the submitted version.

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REFERENCES

Åkerstedt, T. (2019). Shift work – Sleepiness and sleep in transport. *Sleep Medicine Clinics*, *14*, 413–421. https://doi.org/10.1016/j.jsmc.2019.07.003

Åkerstedt, T., Anund, A., Axelsson, J., & Kecklund, G. (2014). Subjective sleepiness is a sensitive indicator of insufficient sleep and impaired waking function. *Journal of Sleep Research*, *23*, 240–252. https://doi.org/10.1111/jsr.12158

Bambra, C., Whitehead, M., Sowden, A., Akers, J., & Petticrew, M. (2008). "A hard day's night?" The effects of compressed working week interventions on the health and work-life balance of shift workers: A systematic review. *Journal of Epidemiology & Community Health*, *62*, 764–777. https://doi.org/10.1136/jech.2007.067249

Booker, L. A., Magee, M., Rajaratnam, S. M. W., Sletten, T. L., & Howard, M. E. (2018). Individual vulnerability to insomnia, excessive sleepiness and shift work disorder amongst healthcare shift workers. A systematic review. *Sleep Medicine Reviews*, *41*, 220–233. https://doi.org/10.1016/j.smrv.2018.03.005

EASA. *Effectiveness of flight time limitation (FTL)*. 2018, 11. https://www.easa.europa.eu/document-library/general-publications/effectiveness-flight-time-limitation-ftl-report

Guimarães, C., Martins, M. V., Vaz Rodrigues, L., Teixeira, F., & Moutinho dos Santos, J. (2012). Sleepiness Scale in obstructive sleep apnea syndrome – An underestimated subjective scale. *Revista Portuguesa De Pneumologia (English Edition)*, *18*, 267–271. https://doi.org/10.1016/j.rppnen.2012.06.005

He, K., & Kapur, V. K. (2017). Sleep-disordered breathing and excessive daytime sleepiness. *Sleep Medicine Clinics*, *12*, 369–382. https://doi.org/10.1016/j.jsmc.2017.03.010

Hudgel, D. W. (2016). Sleep apnea severity classification — Revisited. *Sleep*, *39*, 1165–1166. https://doi.org/10.5665/sleep.5776

Javaheri, S., & Javaheri, S. (2020). Update on persistent excessive daytime sleepiness in obstructive sleep apnea. *Chest*. Advance online publication. https://doi.org/10.1016/j.chest.2020.02.036

Johns, M. W. (1992). Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep*, *15*, 376–381. https://doi.org/10.1093/sleep/15.4.376

Kecklund, G., & Axelsson, J. (2016). Health consequences of shift work and insufficient sleep. *BMJ*, *355*, i5210. https://doi.org/10.1136/bmj.i5210

Knauert, M., Naik, S., Gillespie, M. B., & Kryger, M. (2015). Clinical consequences and economic costs of untreated obstructive sleep apnea syndrome. *World Journal of Otorhinolaryngology-Head and Neck Surgery*, *1*, 17–27. https://doi.org/10.1016/j.wjorl.2015.08.001

MacLean, A. W., Davies, D. R. T., & Thiele, K. (2003). The hazards and prevention of driving while sleepy. *Sleep Medicine Reviews*, *7*, 507–521. https://doi.org/10.1016/S1087-0792(03)90004-9

Reis, C., Mestre, C., Canhão, H., Gradwell, D., & Paiva, T. (2016). Sleep and fatigue differences in the two most common types of commercial flight operations. *Aerospace Medicine and Human Performance*, *87*(9), 811–815. https://doi.org/10.3357/AMHP.4629.2016

Riedy, S. M., Roach, G. D., & Dawson, D. (2020). Sleep-wake behaviors exhibited by shift workers in normal operations and predicted by a biomathematical model of fatigue. *Sleep*, *26*, zsaa049. https://doi.org/10.1093/sleep/zsaa049

Sateia, M. (2014) *International classification of sleep disorders*. Darien, IL: American Academy of Sleep Medicine.

Shattck, N. L., & Matsangas, P. (2015). Psychomotor vigilance performance predicted by Epworth Sleepiness Scale scores in an operational setting with the United States Navy. *Journal of Sleep Research*, *24*, 174–180. https://doi.org/10.1111/jsr.12243

Vantolla, P., Sampsa, P., Kati, K., Tuula, O., & Mikko, H. (2020). Employees with shift work disorder experience excessive sleepiness also on non-work days: A cross-sectional survey linked to working hours register in Finnish hospitals. *Industrial Health*, 483–488. Advance online publication. https://doi.org/10.2486/indhealth.2019-0179

Westerlund, A., Brandt, L., Harlid, R., Åkerstedt, T., & Trolle Lagerros, Y. (2014). Using the Karolinska sleep questionnaire to identify obstructive sleep apnea syndrome in a sleep clinic population. *Clinical Respiratory Journal*, *8*, 444–454. https://doi.org/10.1111/crj.12095

Wittmann, M., Dinich, J., Merrow, M., & Roenneberg, T. (2006). Social Jetlag: Misalignment of biological and social time. *Chronobiology International*, *23*, 497–509.

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